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Comment on soil-2021-26

Anonymous Referee #2

Referee comment on "Soil properties after 36 years of N fertilization under continuous corn and corn-soybean management" by Nakian Kim et al., SOIL Discuss., https://doi.org/10.5194/soil-2021-26-RC2, 2021

The paper provides an account of how various soil properties differ among two crop rotations and three nitrogen rates after 36 years of the treatments. Long-term records such as this are rare, and hence often worthy of publication based the experimental duration alone. However, this work has several key shortcomings owing to experimental design and data analysis/presentation:

- The results are more due to management decisions than the long-term impact of crop rotation and nitrogen fertilizer rate to corn on soil properties. For example, NH4-based fertilizers such as urea ammonium nitrate (UAN) and increasing rates of NH4-based fertilizers are well known to acidify soils. However, farmers cope with this fact by applying lime. So the decrease in pH with increasing N rate is a function of the liming decisions made during execution of the experiment. No farmer would allow pH to fall as low as found in the CCC 269 treatment. Similarly, it is no surprise the pH is higher in CS 269 than CCC 269 because across the 36 years the CS 269 received half of the H+ ions than CCC. Maybe the surprisingly large difference in pH among these treatments is due to extra leaching of cations/nitrate in the CCC? In any case, a more budget-based perspective might help to explain these differences. The P and K results may also be explained this way: the zero N rate treatment almost certainly has higher P because less P was harvested in grain (lower yields). We do not know how this corresponds to K, which leads me to my next major point:

- The data are not presented in a way that they could be used by future investigators. Presenting means of multiple treatments owing to a lack of 'significant' interaction effect is not acceptable. Only for treatments with a significant 3-way interaction does the reader get to see the data. If there is no 3-way interaction, means across multiple

treatments are presented owing to the idea that there was no treatment effect. The SOM data in table 1 are an excellent example: we only see the means for N rate treatments across both rotations or means for the three rotations across the three N rates. Two major sub-points here:

- the data cannot be used by future investigators that might want to conduct a meta-analysis;
- the lack of a statistical difference at p = 0.XX is arbitrary and not indicative of whether or not there was an ecologically meaningful difference and if the experiment/sampling strategy had the statistical power to detect such an effect. Please see the following papers:

Wasserstein, R. L., & Lazar, N. A. (2016). The ASA's Statement on p-Values: Context, Process, and Purpose. *American Statistician*, *70*(2), 129–133. https://doi.org/10.1080/00031305.2016.1154108

Kravchenko, A. N., & Robertson, G. P. (2011). Whole-Profile Soil Carbon Stocks: The Danger of Assuming Too Much from Analyses of Too Little. *Soil Science Society of America Journal*, *75*(1), 235–240. https://doi.org/10.2136/sssaj2010.0076

- Separating the sC and cS is OK, but then the only reason a difference between these systems such as in Figure 5, panel d can be explained is by the previous crop (1-yr effect) and not some long-term effect given that other than the previous crop, the two systems were identical over time. I suppose the 18 weather-years of sC are also different than the 18 weather-years of Cs, but this should average out? Some better discussion of this might be warranted along with an analysis of those two systems averaged.

In summary, there are some potentially interesting results with the pH and CEC, but it's not possible to determine the potential importance of the rest of the results because data are presented across multiple treatments without any context for ecologically relevant effect sizes or the statistical power to detect those effects. This paper, with more complete data presentation, would benefit the agronomic literature, but it does not advance our fundamental or applied understanding of soil processes.